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Oxygen Abundances from Infrared OH Lines

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Abstract. Oxygen abundances are derived from IR-OH lines and compared to published results from UV-OH lines.

1. Introduction

The vibrational-rotational OH lines in the infrared provide a robust alternative to the high-excitation optical O I lines and the electronic transitions of OH in the ultraviolet for the determination of oxygen abundances. Results from the O I lines have been held suspect because they arise from the deep layers of the stellar atmosphere which may not be accurately modeled (Kiselman 1991). Compared to the UV, the IR spectral region is far cleaner and the opacity (mainly H^-) is well understood. According to Grevesse et al. (1984) the IR-OH lines provide the most reliable value of the oxygen abundance in the Sun. Following our pioneering use of the IR-OH lines in the study of the metal-poor dwarf Gmb 1830 (Balachandran & Carney 1996), we now discuss new results from several additional metal-poor subgiants and giants.

2. Infrared Observations and Analyses

Our data were obtained with CSHELL, the infrared echelle spectrograph on NASA's IRTF telescope. The spectral resolution was R=40,000 in the H band, where the overtone OH lines are found, and R=20,000 in the L band where the fundamental OH lines are found. We observed 6 giants and 2 subgiants with metallicities between $-2.9 < [Fe/H] < -1.0$. The effective temperatures of our stars were obtained from colors, and the results are in good agreement with Alonso et al.'s (1999) IRFM calibration. When possible, gravities were obtained by requiring ionization equilibrium between Fe I and Fe II. For the subgiants, when the Fe II lines are weak and Hipparcos parallax errors are

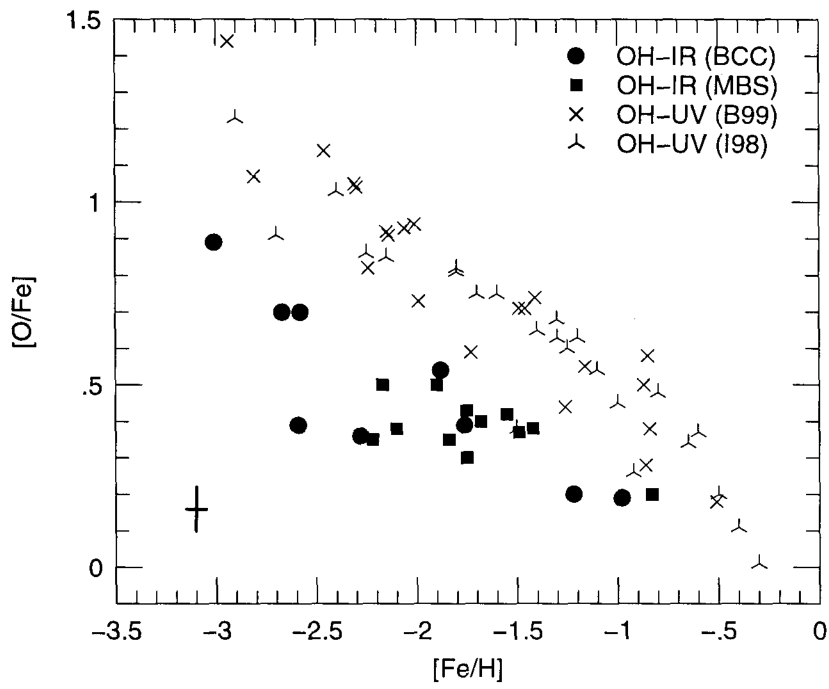

Figure 1. The trend of [O/Fe] vs. [Fe/H] for oxygen abundances derived from UV-OH lines (skeletal symbols) from Israelian et al. (1998) and Boesgaard et al. (1999), is compared to results from IR-OH lines (filled symbols) from Balachandran et al. (2000) and Mélendez et al. (2000). The Boesgaard et al. results are on the King temperature scale. All abundances are plotted with respect to the solar oxygen abundance of log ϵ(O)=8.87. The typical error in temperature and [O/Fe] in our study is indicated by the error bar.

small, we adopted gravities based on the parallax. Oxygen abundances were determined from equivalent width measurements using MOOG. To obtain consistent results, it is crucial that both the oxygen and iron abundances be derived from the same model atmosphere grid using the same parameters. We therefore used equivalent widths of Fe I lines from the literature, to derive Fe abundances.

Because of space constraints, the individual stellar parameters and abundances are not listed here but will be provided in a later publication. We include in this discussion the data of Meléndez, Barbuy and Spite (2000) which was presented as a poster paper at this Joint Discussion. Their data were obtained with the Phoenix high-resolution infrared spectrograph at the 2.1m telescope at KPNO. Their OH spectra are all in the H-band, and their sample of 9 giants, 3 subgiants and 3 dwarfs span the metallicity range $-2.2 < [Fe/H] < -0.8$. Discussion of their analysis can be found in Meléndez et al. (2000).

3. Results

Figure 1 compares the trend of [O/Fe] vs. [Fe/H] from the IR-OH and UV-OH lines. The latter are taken from Israelian et al. (1998) and Boesgaard et al. (1999). The dichotomy between the two trends is readily apparent. While the UV-OH results show a steadily increasing [O/Fe] with decreasing metallicity, the IR-OH results show that [O/Fe] is flat with metallicity between $-2.2 <$ [Fe/H] $<$ -1.0. The difference between the two trends is roughly 0.5 dex at [Fe/H] $= -2.0$. The data are sparse below [Fe/H] < -2.2, but the IR-OH results suggest either a change in the slope of [O/Fe] or an increased scatter, or both.

The cause of the high abundances from the UV-OH lines remains to be understood (see Asplund, these proceedings). However the agreement between the IR-OH and the [OI] line abundances (see Sneden, these proceedings) and the basic agreement of these trends with the Galactic chemical models (see Matteucci, these proceedings) combine to suggest that the low oxygen abundances represent the more definitive trend.

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